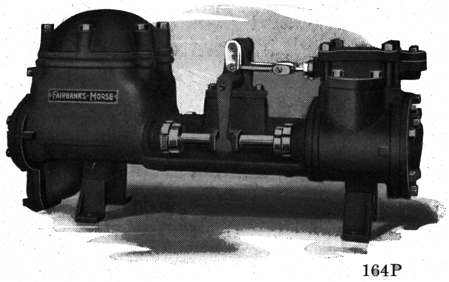
Fairbanks-Morse

Boiler Feed and General Service Steam Pumps



164P

Fairbanks, Morse & Co.
(INCORPORATED)
Chicago, Ill.

Atlanta, Ga.
Baltimore, Md.
Boston, Mass.
Buenos Aires
Cincinnati, Ohio
Cleveland, Ohio
Dallas, Tex.
Denver, Colo.
Des Moines, Ia.
Detroit, Mich.
Indianapolis, Ind.
Jacksonville, Fla.
Kansas City, Mo.
London
Los Angeles, Cal.
Louisville, Ky.
Milwaukee, Wis.
Minneapolis, Minn.
New Orleans, La.
New York, N. Y.
Omaha, Neb.
Portland, Ore.
Salt Lake City, Utah
San Francisco, Cal.
Seattle, Wash.
Spokane, Wash.
St. Louis, Mo.
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Fairbanks-Morse Co. (Australasia), Limited
Sydney, N. S. W.
Auckland, New Zealand
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The Canadian Fairbanks-Morse Co., Limited
St. John, N. B.
Quebec
Montreal
Ottawa
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Windsor
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Victoria

BULLETIN 148C

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112205

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Boiler Feed and General Service

The machines shown are nearly all of the duplex pattern, and the steam mechanism is so well known as to require but a word of mention.

The duplex pumps consist practically of two pumps placed side by side and so arranged that the steam valve of one side receives its motion from the main piston of the opposite side. This construction is very simple and makes it impossible for the pump ever to stop on a dead center.

As we use flat slide steam valves, carefully fitted to the cylinder faces, we can guarantee that our pumps will be found positive and durable under all conditions of service.

It is our aim to build pumps which will be economical in operation and durable in service.

All parts are made to gauge and therefore interchangeable.

Every machine, after being thoroughly inspected and tested at the factory under various speeds and pressures, is painted, the interior of the steam end thoroughly oiled, and water piston packing removed, dried and replaced.

The water pistons are submerged and the water valves are all located above the pistons.

All fittings such as wrenches, drain valves, etc., are boxed and securely attached to the pump.

An extra charge is made for boxing for export shipment or when a pump must be specially "knocked down."

Packing for stuffing boxes, foundation bolts and nuts, throttle valves, governors, gauges, piping, etc., are not furnished unless at an extra cost. They will be supplied at market prices when ordered.

Regular construction of all Piston Pattern Pumps listed on the following pages, includes steel piston rods, iron piston rod stuffing boxes and iron water pistons and followers.

Air chambers are not supplied regularly with Duplex Piston Pattern Pumps, up to and including 8x6x12, as the nature of the work to which these pumps are usually put is such that an air chamber is of no benefit. For situations where air chambers are needed they can be furnished at a slight extra cost. Air chambers are regularly made of close-grained cast iron.

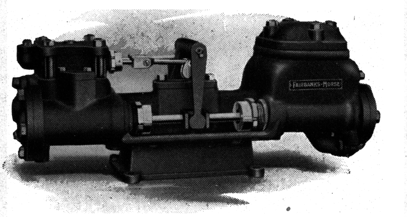
In any line of machinery containing such a diversity of sizes and styles, of which the larger machines must of necessity be modified somewhat in design from the smaller sizes, it is almost impossible to refer in a catalogue to every slight difference in these details of design. Hence, it will be advantageous for our customers to obtain from us specific information concerning the particular pump they may have under consideration.

The pipe sizes and dimensions given in the catalogue are subject to change whenever it may be necessary for us to do so. Hence, a blue print should be obtained for every pump ordered, which will give correctly the pipe sizes, and other information needed to properly install the pump.

The displacement shown for these pumps is actual piston or plunger displacement, ignoring the rod.

Fairbanks-Morse Steam Pumps

Boiler Feed Pumps—Duplex Piston Pattern



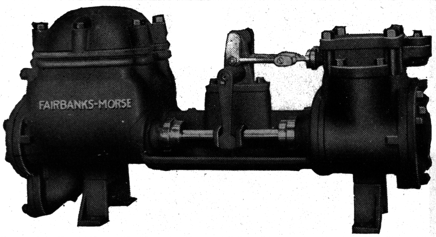
343P

343P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
3	2	4

164P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
4½	3	4
5¼	3½	5
6	4	6



164P

For Boiler Pressures not exceeding 150 pounds

While various patterns of pumps that we build may be used for boiler feeding the following sizes are selected as being perhaps the best proportioned for that particular service when pumping clean water.

The general design of these pumps is shown in section by SP208, page 5.

These pumps are fitted with either brass or rubber valves, as desired. When pumping cold water, soft or medium rubber valves are preferable, but when pumping hot water the valves should be of hard rubber, or brass.

The ratings given below are very conservative, but while the pumps can be speeded up to a greater capacity, it is evident that if pumps are selected on the lower rating it means increased life to the pump and a decreased cost for maintenance. See Notes 2 and 3, page 12.

Diameter of Steam Cylinder, Inches	Diameter of Water Cylinder, Inches	Length of Stroke, Inches	Displacement in Gallons per Stroke of One Piston	Horse-Power of Boilers Pump Will Supply at an Easy Speed	Diameter of Pipe for Short Lengths, Inches				Floor Space, Inches	Telegraphic Code Word
					Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe		
3	2	4	.05	75	⅜	½	1¼	1	30x11	Pabal
4½	3	4	.12	150	½	¾	2	1½	35x13	Pabek
5¼	3½	5	.20	300	1	1¼	2½	1½	39x16	Pabla
6	4	6	.33	450	1	1½	3	2	45x17	Pabre
* 7	4½	7	.48	550	1½	2	4	3	52x20	Pabox
* 7	5	7	.59	650	1½	2	4	3	52x20	Pabmo
* 7	4½	10	.69	750	1½	2	4	3	68x22	Pabon
* 7	5	10	.85	900	1½	2	4	3	68x22	Pabxy
† 8	5	12	1.02	1000	1½	2	4	3	72x23	Pabst
††10	6	12	1.47	1400	2	2½	5	4	72x28	Pabul

*Sizes 7x4½x7 to 7x5x10, inclusive, are similar in appearance to 533P, on page 4.

†Size 8x5x12 is similar in appearance to 499P, on page 4.

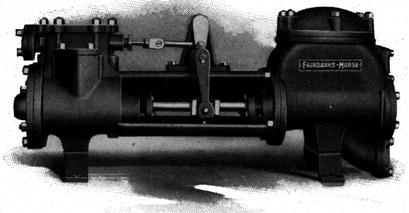
††Size 10x6x12 is similar in appearance to 568P, on page 4.

Size 10x6x12 is provided with air chamber. Other sizes listed above are **not** regularly so fitted.

Any of the above pumps can be furnished brass fitted at a slight additional cost.

Where the boiler pressure exceeds 150 pounds per square inch we recommend the use of our outside packed plunger pumps.

General Service Pumps—Duplex Piston Pattern



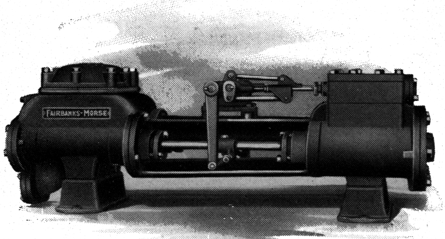
533P

499P

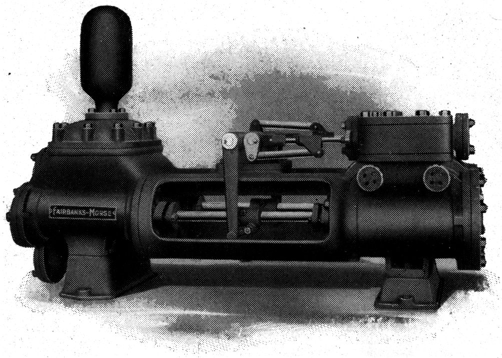
Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
7	6	10
8	4	12
8	5	12
8	6	12

533P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
7	4½	7
7	5	7
7	4½	10
7	5	10



499P



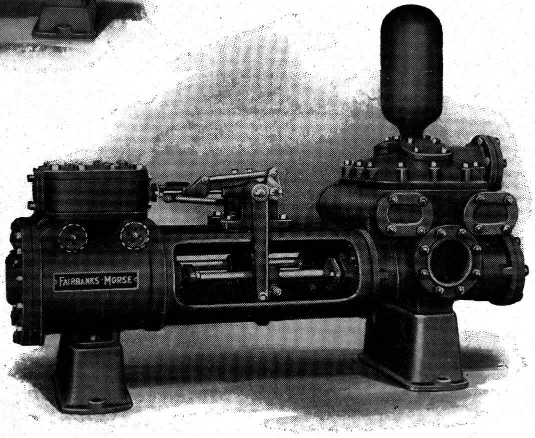
568P

501P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
10	7	12
12	7	12
14	7	12

568P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
7	7	7
10	5	12
10	6	12

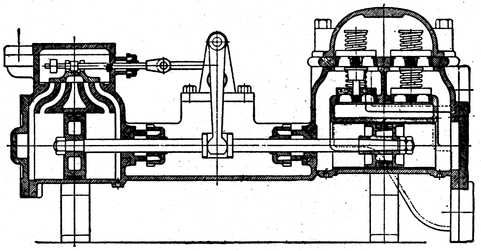


501P

General Service Pumps—Duplex Piston Pattern

The cuts on the opposite page illustrate Fairbanks-Morse Piston Pattern Pumps for general service. They are designed for water pressures not exceeding 150 pounds per square inch.

The stuffing boxes are all of ample depth, and all parts of the machines easily accessible for examination or repairs.



SP208. Details of Duplex Piston Pattern Boiler Feed and General Service Pump.

Diameter of Steam Cylinders, Inches	Diameter of Water Cylinders, Inches	Length of Stroke, Inches	Displacement in Gallons, per Stroke, of One Piston	Piston Travel, in Feet, per Minute, Conservative Rating	Displacement in Gallons, per Minute, at Rated Speed	Pipe Sizes for Short Lengths, Inches				Floor Space, Inches	Telegraphic Code Word
						Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe		
3	2	4	0.05	35	11	⅜	½	1¼	1	30x11	Parab
4½	3	4	.12	35	25	½	¾	2	1½	35x13	Parba
5¼	3½	5	.20	40	40	1	1¼	2½	1½	39x16	Parce
6	4	6	.33	45	58	1	1½	3	2	45x17	Parck
7	4½	7	.48	55	91	1½	2	4	3	52x20	Parky
7	5	7	.59	55	112	1½	2	4	3	52x20	Pared
7	4½	10	.69	70	116	1½	2	4	3	68x22	Parfe
7	5	10	.85	70	142	1½	2	4	3	68x22	Pargh

Size 3x2x4 is similar in appearance to 343P, on page 3.
Sizes 4½x3x4 to 6x4x6, inclusive, similar in general design to 164P, page 3.
Sizes 7x4½x7 to 7x5x10, inclusive, similar in general design to 533P, page 4.
See Notes 2 and 3, page 12, concerning capacities.

Fairbanks-Morse pumps in the following sizes are made with style of steam valve mechanism as shown by 499P, 568P and 501P on opposite page.

Aside from this feature the details of design are practically the same as in the smaller sizes mentioned above.

They will stand a constant water pressure not exceeding 150 pounds.

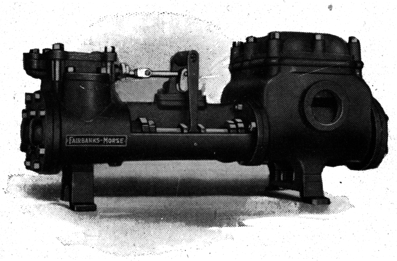
8	4	12	0.66	80	106	1½	2	4	3	72x23	Parhg
8	5	12	1.02	80	163	1½	2	4	3	72x23	Parig
10	5	12	1.02	80	163	2	2½	5	4	74x28	Parjo
10	6	12	1.47	80	235	2	2½	5	4	74x28	Parkn
10	7	12	2.00	80	320	2	2½	6	5	76x28	Parlk
12	7	12	2.00	80	320	2½	3	6	5	78x31	Parma
14	7	12	2.00	80	320	2½	3	6	5	80x38½	Parne
*10	8½	12	2.94	80	470	2	2½	7	6	80x32	Parno
*12	8½	12	2.94	80	470	2½	3	7	6	80x32	Paron
†14	8½	12	2.94	80	470	2½	3	7	6	80x38½	Parps
†16	8½	12	2.94	80	470	2½	3	7	6	90x41	Parqr
†14	10	12	4.08	80	652	2½	3	8	7	85x38½	Parst
†16	10	12	4.08	80	652	2½	3	8	7	90x41	Parus

*Sizes 10x8½x12 and 12x8½x12 are similar in appearance to 497P, on page 6.

†Sizes 14x8½x12 to 16x10x12, inclusive, are similar in appearance to 497P, page 6, except water box has end suction and discharge.

Any of the above pumps will be furnished brass fitted at a slight additional cost.
10x5x12 and larger sizes are fitted regularly with air chambers.
Smaller sizes are not so fitted.
See Notes 2 and 3, page 12, concerning capacities.

Low Service or Tank Pumps—Duplex Piston Pattern



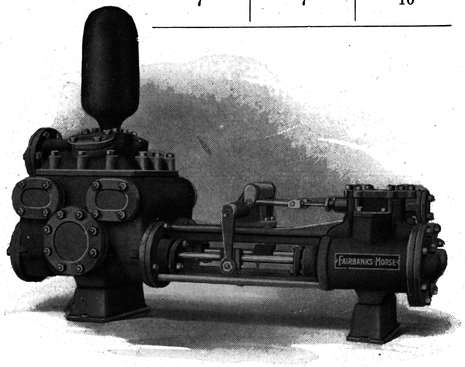
339P

339P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
3	2½	4
4½	3¾	4
5¼	4¼	5
5¼	5	5
5¼	5¾	5
6	5	6
6	5¾	6
7	6	7

556P

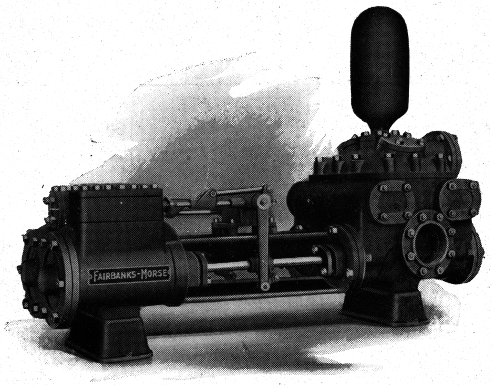
Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
7	7	10



556P

497P

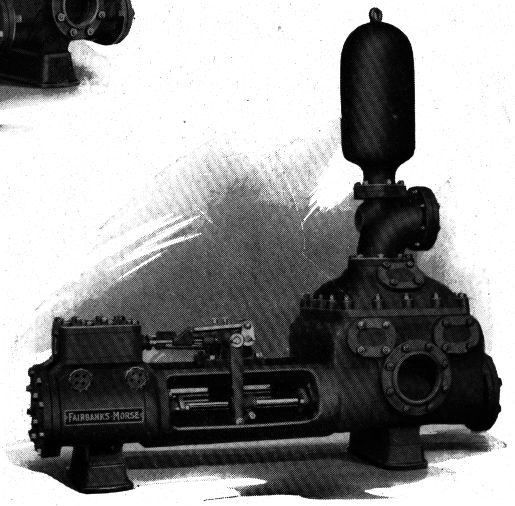
Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
10	8½	12
10	10	12
12	8½	12
14	8½	12
14	10	12
16	8½	12
16	10	12



538P

538P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
8	7	12
8	8½	12



497P

Low Service or Tank Pumps—Duplex Piston Pattern

Our piston pattern pumps of this type have water ends of the general design shown by SP208, on page 5. These pumps are especially designed for elevating water, or other liquids, to a moderate height with a small consumption of steam.

For work where the head to be pumped against is not too high, they are, by reason of their cylinder proportions, more economical in consumption of steam than our general service pumps.

They are designed for use in connection with railway water stations, breweries, gas works, tanneries, oil works, bleacheries, sugar refineries, etc.

They are designed for water pressures not exceeding 75 pounds per square inch.

Diameter of Steam Cylinders, Inches	Diameter of Water Cylinders, Inches	Length of Stroke, Inches	Displacement in Gallons per Stroke of One Piston	Piston Travel, in Feet, per Minute, Conservative Rating	Displacement in Gallons, per Minute, at Rated Speed	Pipe Sizes for Short Lengths, Inches				Floor Space, Inches	Telegraphic Code Word
						Steam Pipe	Exhaust Pipe	Suction Pipe	Discharge Pipe		
* 3	2½	4	.08	35	17.8	⅜	½	1¼	1	28x11½	Para
4½	3¾	4	.19	35	41	½	¾	2½	2	36x13½	Pamab
* 5¼	4¼	5	.31	40	58	1	1¼	3	2	38½x16	Pamek
* 5¼	5	5	.42	40	81	1	1¼	4	3	39x16	Pamox
5¼	5¾	5	.56	40	107	1	1¼	4	3	42x18	Paneb
* 6	5	6	.51	45	92	1	1½	4	3	45x17	Panha
6	5¾	6	.67	45	120	1	1½	4	3	46x18	Panij
7	6	7	.85	55	160	1½	2	5	4	57x19	Panra
‡† 7	7	7	1.16	55	220	1½	2	6	5	58x24½	Panse
§ 7	6	10	1.22	70	205	1½	2	5	4	67x22	Pantx
‡ 7	7	10	1.66	70	280	1½	2	6	5	72x26	Panya
§ 8	6	12	1.47	80	233	1½	2	5	4	72x23	Papab
‡ 8	7	12	2.00	80	320	1½	2	6	5	75x26	Papba
‡ 8	8½	12	2.94	80	472	1½	2	6	5	76x27	Papef
‡10	10	12	4.08	80	652	2	2½	8	7	85x33	Papgi

*These sizes have suction opening on the end. All other sizes have suction opening on the side.

†7x7x7 similar appearance to 568P, page 4, except water box has side suction.

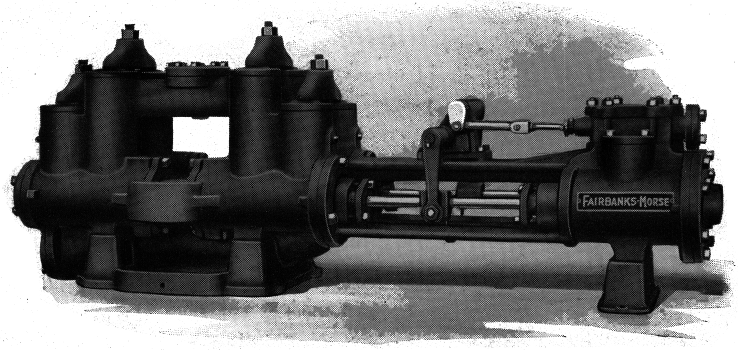
‡These sizes are regularly fitted with an air chamber.

§Sizes 7x6x10 and 8x6x12 similar in appearance to 499P, page 4, except water box has side suction.

Any of the above sizes will be furnished brass fitted at a slight additional cost.

See Notes 2 and 3, page 12, concerning capacities.

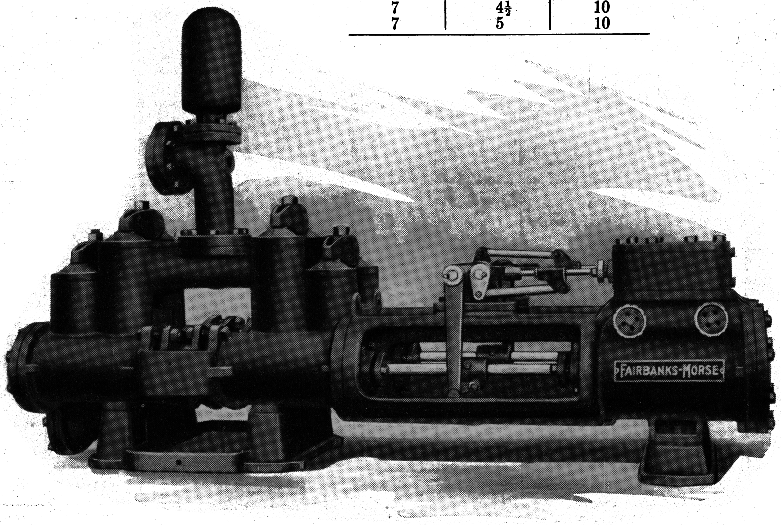
Duplex Outside Center Packed Plunger Pumps



560P

560P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
4½	2¼	4
5¼	3	5
6	3½	6
7	4½	7
7	5	7
7	4½	10
7	5	10



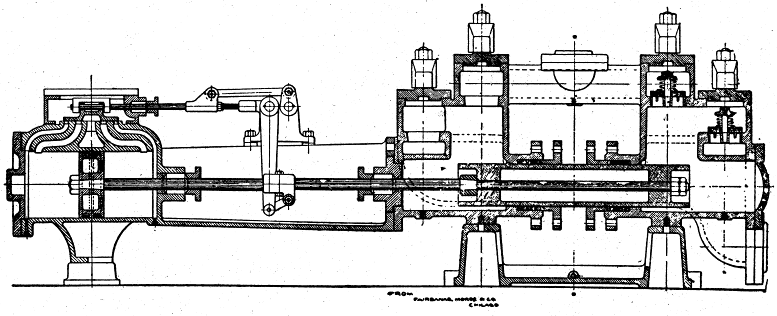
548P

548P. Illustrating sizes 8x5x12 to 12x6x12, inclusive, except that 8x5x12 is not regularly supplied with air chamber and cushion valves.

548P

Steam Cylinder Diameter, Inches	Water Cylinder Diameter, Inches	Stroke, Inches
8	5	12
8	6	12
10	5	12
10	6	12
12	6	12

Duplex Outside Center Packed Plunger Pumps



SP239. Details of Outside Center Packed Pumps.

These pumps are of a type especially adapted for situations where the liquid to be handled contains considerable grit or sand, or where the pressure to be pumped against is moderately high. They are also well adapted for handling hot water.

In this type of pump, the plungers being externally packed, are always in sight of the attendant engineer, and any leakage can be at once detected, and the stuffing boxes adjusted or repacked very quickly.

All parts of these pumps are easy of access, the arrangement of the water end being such as to permit the water valves being easily reached. All the stuffing boxes are large and deep, so that an ample amount of packing may be used.

All parts of the pumps are heavily proportioned, with a view to their being durable under the heavy service for which they are commonly used.

The pump ends of the machines listed will stand a constant working pressure not exceeding 200 pounds. We can furnish machines of this type with pump ends strong enough for 250 pounds working pressure.

Diameter of Steam Cylinders, Inches	Diameter of Water Plungers, Inches	Length of Stroke, Inches	Displacement in Gallons per Stroke of One Plunger	Piston Travel, in Feet, per Minute, Conservative Rating	Displacement in Gallons per Minute by Both Plungers at Rated Speed	Sizes of Pipes for Short Lengths, Inches				Floor Space, Inches	Telegraphic Code Word
						Steam	Exhaust	Suction	Discharge		
4½	2¼	4	0.07	35	15	½	¾	2	1½	48x13½	Paisano
5¼	3	5	.15	40	30	1	1¼	3	2	56x17	Pajock
6	3½	6	.25	45	45	1	1½	3	2	60x17	Pakole
* 7	4½	7	.48	55	91	1½	2	4	3	72x21	Pifan
* 7	5	7	.59	55	112	1½	2	4	3	72x21	Pifna
* 7	4½	10	.69	70	116	1½	2	4	3	88x22½	Pedtu
* 7	5	10	.85	70	142	1½	2	4	3	88x22½	Pedut
† 8	5	12	1.02	80	163	1½	2	4	3	94x25	Pedvx
†10	5	12	1.02	80	163	2	2½	4	3	97x27	Pedwy
† 8	6	12	1.47	80	235	1½	2	5	4	98x29	Pedxa
†10	6	12	1.47	80	235	2	2½	5	4	98x29	Pefab
†12	6	12	1.47	80	235	2½	3	5	4	102x31	Pefba

*Sizes 4½x2¼x4 to 7x5x10, inclusive, are similar in appearance to 560P.

†Sizes 8x5x12 to 12x6x12, inclusive, are similar in appearance to 548P, excepting that sizes 8x5x12 and 8x6x12 are not regularly provided with air chamber or cushion valves.

Any of the above pumps will be fitted with composition plungers, lined glands, and bronze rods at a slight additional cost.

See Notes 2 and 3, page 12, concerning capacities.

Points of Interest to Pump Buyers

Our complete file of pump bulletins cover various types of pumping apparatus in which will be found illustrated a large variety of machines for handling liquids.

The application of pumping machinery to commercial purposes is so varied and requires such a diversity of types and sizes that we have not attempted to do more than list sizes and types most commonly used. We invite correspondence from anyone interested in pumping problems, even though the type or size of pump does not seem to be listed in these bulletins. We build and are in a position to supply pumping machinery suitable for many different lines of service.

It will facilitate correspondence and be to our customers' advantage if they will write us fully regarding their requirements and answer carefully the following questions:

First—For what purpose is the pump to be used? Under this caption the nature of the service should be specified, whether municipal water works, factory or domestic water supply, fire protection, irrigation, drainage, etc. It is also an advantage to know if the service is to be continuous, 24 hours per day and seven days a week, or what is the probable frequency of operation or longest continuous period.

Second—The maximum quantity to be pumped per minute, hour or day. This is usually given in United States gallons per minute and if any other rating is used it must be specified, as we will otherwise assume that gallons per minute is understood. In handling oil it is usual to give the capacity and number of barrels (42 gallons each) per hour.

Third—The steam pressure available to operate the pump and whether the pump is to operate condensing, exhausting into the atmosphere or exhausting against a pressure. If the last condition, give the amount of back pressure. We should know the steam pressure available at the pump, because if the steam pipe is long there will be considerable loss from condensation.

Fourth—What height is the water to be lifted by suction? The size of the suction pipe should be stated, the approximate length of it, the number of elbows, tees, valves or other fittings in it and whether provided with a foot valve.

Fifth—To what height or against what pressure is the water to be forced by the pump. If the total pressure is not known, give the difference in elevation between the pump and the highest point in the discharge system; in other words, the static head. The size and probable length of pipe and its condition, whether new or old.

Sixth—The nature of the liquid to be handled must be specified. If water, we should know whether it is cold or hot, fresh or salt, clear or gritty, alkaline or ascidulous, or whether it contains any substance either in solution or suspension in considerable quantity. If oil, we must know the specific gravity or Baume hydrometer reading. It is also of advantage to have the viscosity if this is known. We can sometimes form a pretty good idea of the nature of the oil from the locality from which it is derived. Any other substances to be handled should be described accurately as different liquids require special fittings, special valves and sometimes an altogether different material for the fluid end than that used for oil or water.

A Few Important Facts for Consideration in Connection with the Purchase and Installation of Steam Pumps

For making pipe connections use full round bends rather than elbows and as few of these as practicable.

If the suction lift is high or the suction pipe long, a priming connection is necessary, and in such cases a vacuum chamber should be used to obtain smooth operation of pump.

Where the suction lift is high, a foot valve is essential to maintain the suction pipe full of water, which insures quick starting of the pump.

It is not practical to lift hot water by suction, since its vapors tend to destroy the necessary vacuum; therefore, a pump for handling hot water should be placed below the source of supply. Such a pump should be fitted with hard rubber or brass valves.

Useful Information and Formulae for Solving Pump Problems

1. Diameter multiplied by 3.1416 = circumference.

2. Circumference multiplied by .3183 = diameter.

3. The square of the diameter multiplied by .7854 = area.

4. A gallon of fresh water weighs 8⅓ lbs. and contains 231 cubic inches.

5. A cubic foot of water weighs 62.35 lbs. and contains 1,728 cubic inches, or 7½ gallons.

6. A cubic foot per second equals 450 gallons per minute.

7. An acre-foot is 325,829 gallons per minute.

8. The term "miner's inch" of water is more or less indefinite, but is approximately equal to a flow of 11¼ gallons per minute. This varies in different States from about 9 to 13 gallons per minute.

9. To find the diameter of a pump cylinder required to move a given quantity of water per minute, the piston travel being 100 feet per minute, divide the number of gallons by four, then extract the square root and the result will be the diameter in inches.

10. To find the area of required pipe, the volume of water being known, multiply the number of cubic feet of water by 144 and divide the product by the velocity in feet per minute. This gives the area of pipe, from which it is easy to determine the diameter.

11. To find the velocity in feet per minute necessary to discharge a given volume of water in a given time, multiply the number of cubic feet of water by 144 and divide the product by the area of the pipe in inches.

12. With steam pumps the area of the steam piston multiplied by the steam pressure gives the total amount of pressure exerted. The area of the water piston multiplied by the pressure of water per square inch gives the resistance. A margin must be made between the power and resistance to move the pistons at the required speed, usually reckoned at from 25 to 40 per cent.

D = Diameter of cylinder in inches.
S = Length of stroke in inches.
N = Total number of strokes per minute.
G = Quantity in gallons per minute.
H = Height in feet water is elevated.
A = Area of cylinder in square inches.

Area of cylinder in square inches $= D^2 \times .7854$

Capacity of pump per stroke in cubic inches $= S \times A$

Capacity of pump per stroke in gallons $= \dfrac{S \times A}{231}$

Capacity of pump per stroke in cubic feet $= \dfrac{S \times A}{1728}$

Capacity of pump per stroke in pounds $= \dfrac{S \times A \times 8\frac{1}{3}}{231}$

Capacity of pump per minute in cubic inches $= S \times N \times A$

Capacity of pump per minute in gallons (G) $= \dfrac{S \times N \times A}{231}$

Capacity of pump per minute in cubic feet $= \dfrac{S \times N \times A}{1728}$

Pressure per square inch in pounds of a column of water $= H \times .433$

Theoretical horse-power required to elevate a given quantity of water per minute to a given height, not allowing for friction $\left.\right\} = \dfrac{G \times H \times 8\frac{1}{3}}{33000}$

A Few Words in Reference to Piston Travel and Capacities of Direct Acting Steam Pumps

Although it has been in the past quite customary in rating the capacity of pumps to make the basis of the capacity a piston travel of 100 feet per minute, yet it is very evident that for short stroke pumps, by which we refer particularly to pumps of 10 inches and shorter stroke, this rating gives a speed so great that the pumps would not be durable in every-day service.

The following list, showing the number of strokes required to attain 100 feet piston speed, will, we believe, make the point clear:

3-inch stroke pump must make 400 strokes per minute.
4-inch stroke pump must make 300 strokes per minute.
5-inch stroke pump must make 240 strokes per minute.
6-inch stroke pump must make 200 strokes per minute.
7-inch stroke pump must make 171 + strokes per minute.
10-inch stroke pump must make 120 strokes per minute.

The capacity of a pump, having voluntary valves, **i. e.,** the amount of water which it will deliver, is limited by the number of times the valves may open and close safely and without violent slamming, instead of being limited by the piston travel in feet per minute.

Therefore, it is evident that for pumps of 7 inches and shorter stroke, the number of strokes given above are so great that the pumps would not be durable, showing that 100 feet as a basis for capacity of all lengths of stroke is not a fair basis for comparison.

It will be found on examining the lists of sizes in our bulletins that we have designed our pumps of relatively long stroke. As this does not prevent running up to the number of strokes given for pumps having shorter lengths of stroke, **it is clear that for the same number of strokes our long stroke pumps will have a much greater capacity.**

The following table shows the number of strokes required to attain a piston travel of from 50 feet to 125 feet per minute for pumps having strokes from 3 inches to 18 inches in length:

Piston Travel in Feet per Minute	LENGTH OF STROKE IN INCHES.									
	3	4	5	6	7	8	10	12	15	18
	NUMBER OF STROKES PER MINUTE.									
50	200	150	120	100	86	75.	60	50	40	33
55	220	165	132	110	94	82.5	66	55	44	37
60	240	180	144	120	103	90.	72	60	48	40
65	260	195	156	130	111	97.5	78	65	52	43
70	280	210	168	140	120	105.	84	70	56	47
75	300	225	180	150	128	112.5	90	75	60	50
80	320	240	192	160	137	120.	96	80	64	53
85	340	255	204	170	146	127.5	102	85	68	57
90	360	270	216	180	154	135.	108	90	72	60
95	380	285	228	190	163	142.5	114	95	76	63
100	400	300	240	200	171	150.	120	100	80	67
105	420	315	252	210	180	157.5	126	105	84	70
110	440	330	264	220	188	165.	132	110	88	73
115	460	345	276	230	197	172.5	138	115	92	77
120	480	360	288	240	206	180.	144	120	96	80
125	500	375	300	250	214	187.5	150	125	100	83

NOTE 1.—To find the number of plunger displacements in a duplex pump, multiply the number of strokes as given above by 2.

NOTE 2.—It is evident that considerable judgment must be exercised in determining the proper size of pump to use for a given work, and the questions of speed, pressure, the number of hours per day the pump is to operate, etc., must all be carefully considered when making the selection.

NOTE 3.—An examination of our bulletin will show that we have rated our pumps on a very conservative basis, although any of the machines can be operated under suitable conditions, from 25 to 50 per cent faster than the ratings given.

Water Head in Feet with Equivalent in Pounds Pressure per Square Inch

Head Feet	Pounds Pressure	Head Feet	Pounds Pressure	Head Feet	Pounds Pressure	Head Feet	Pounds Pressure
1	.433	36	15.60	71	30.75	130	56.29
2	.866	37	16.03	72	31.20	135	58.45
3	1.299	38	16.47	73	31.61	140	60.62
4	1.732	39	16.90	74	32.05	145	62.78
5	2.17	40	17.33	75	32.50	150	64.95
6	2.60	41	17.76	76	32.92	155	67.11
7	3.03	42	18.20	77	33.35	160	69.28
8	3.47	43	18.63	78	33.80	165	71.45
9	3.90	44	19.06	79	34.21	170	73.61
10	4.33	45	19.50	80	34.65	175	75.77
11	4.77	46	19.93	81	35.10	180	77.94
12	5.20	47	20.37	82	35.53	185	79.10
13	5.63	48	20.80	83	35.95	190	82.27
14	6.07	49	21.25	84	35.40	195	84.43
15	6.50	50	21.65	85	36.80	200	86.60
16	6.93	51	22.10	86	37.25	210	90.93
17	7.37	52	22.55	87	37.70	220	95.26
18	7.80	53	22.95	88	38.10	230	99.59
19	8.23	54	23.40	89	38.55	240	103.92
20	8.66	55	23.82	90	39.00	250	108.25
21	9.10	56	24.25	91	39.40	260	112.58
22	9.54	57	24.70	92	39.83	270	116.91
23	9.87	58	25.11	93	40.30	280	121.24
24	10.40	59	25.56	94	40.70	290	125.57
25	10.83	60	26.00	95	41.20	300	129.90
26	11.27	61	26.41	96	41.60	350	151.55
27	11.70	62	26.85	97	42.00	400	173.20
28	12.13	63	27.30	98	42.45	450	194.85
29	12.56	64	27.72	99	42.80	500	216.50
30	13.00	65	28.18	100	43.30	600	259.80
31	13.43	66	28.60	105	45.50	700	303.10
32	13.86	67	29.10	110	47.70	800	346.40
33	14.30	68	29.45	115	49.80	900	389.70
34	14.73	69	29.90	120	52.00	1000	433.00
35	15.17	70	30.32	125	54.20	1500	649.50

Water Pressure per Square Inch in Pounds

With Equivalent Water Head in Feet

Pounds Pressure	Head Feet	Pounds Pressure	Head Feet	Pounds Pressure	Head Feet
1	2.31	35	80.8	69	159.5
2	4.62	36	83.2	70	161.8
3	6.93	37	85.5	71	164.0
4	9.24	38	87.8	72	166.3
5	11.55	39	90.1	73	168.7
6	13.86	40	92.4	74	171.0
7	16.18	41	94.7	75	173.3
8	18.49	42	97.0	76	175.7
9	20.80	43	99.3	77	177.9
10	23.10	44	101.7	78	180.2
11	25.40	45	104.0	79	182.6
12	27.70	46	106.3	80	184.8
13	30.00	47	108.6	81	187.1
14	32.35	48	111.0	82	189.5
15	34.62	49	113.2	83	191.7
16	36.98	50	115.5	84	194.1
17	39.25	51	117.8	85	196.4
18	41.60	52	120.1	86	198.7
19	43.80	53	122.5	87	201.0
20	46.20	54	124.8	88	203.5
21	48.50	55	127.1	89	205.8
22	50.80	56	129.4	90	208.0
23	53.20	57	131.8	91	210.1
24	54.40	58	134.0	92	212.5
25	57.75	59	136.3	93	215.0
26	60.10	60	138.6	94	217.3
27	62.30	61	141.0	95	219.6
28	64.70	62	143.2	96	221.9
29	67.00	63	145.6	97	224.2
30	69.30	64	147.9	98	227.5
31	71.70	65	150.2	99	229.8
32	73.90	66	152.4	100	231.0
33	76.30	67	154.8		
34	78.60	68	157.2		

Table of Effective Fire Streams

Using 100 feet of 2½-inch ordinary best quality rubber-lined hose between nozzle and hydrant, or pump. Figures based on smooth nozzle.

Smooth Nozzle, Size	¾-Inch						⅞-Inch						1-Inch					
Pressure at Hydrant, lbs	32	43	54	65	75	86	34	46	57	69	80	91	37	50	62	75	87	100
Pressure at Nozzle, lbs	30	40	50	60	70	80	30	40	50	60	70	80	30	40	50	60	70	80
Press. lost in 100 ft. 2½-inch hose, lbs	2	3	4	5	5	6	4	6	7	9	10	11	7	10	12	15	17	20
Vertical height, ft	48	60	67	72	76	79	49	62	71	77	81	85	51	64	73	79	85	89
Horizontal distance, ft	37	44	50	54	58	60	42	49	55	61	66	70	47	55	61	67	72	76
Gallons discharged per minute	90	104	116	127	137	147	123	142	159	174	188	201	161	186	208	228	246	263

Smooth Nozzle, Size	1⅛-Inch						1¼-Inch						1⅜-Inch					
Pressure at Hydrant, lbs	42	56	70	84	98	112	49	65	81	97	113	129	58	77	96	116	135	154
Pressure at Nozzle, lbs	30	40	50	60	70	80	30	40	50	60	70	80	30	40	50	60	70	80
Press. lost in 100 ft. 2½-inch hose, lbs	12	16	20	24	18	32	9	25	31	37	43	49	28	37	46	56	65	74
Vertical height, ft	52	65	75	83	88	92	53	67	77	85	91	95	55	69	79	87	92	97
Horizontal distance, ft	50	59	66	72	77	81	54	63	70	76	81	85	56	66	73	79	84	88
Gallons discharged per minute	206	238	266	291	314	336	256	296	331	363	392	419	315	363	406	445	480	514

"Two hundred and fifty gallons per minute is a good standard fire stream at 80 pounds pressure at the hydrant. One hundred pounds pressure should not be exceeded except for very high buildings or lengths of hose exceeding 300 feet."

Table of Theoretical Horse-Power Required to Raise Water to Different Heights

Gallons per Minute	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet	30 Feet	35 Feet	40 Feet	45 Feet	50 Feet	60 Feet	Gallons per Minute
5	.006	.012	.019	.025	.031	.038	.044	.050	.057	.063	.076	5
10	.012	.025	.038	.050	.063	.076	.088	.101	.113	.126	.151	10
15	.019	.038	.057	.076	.095	.114	.133	.151	.170	.189	.227	15
20	.025	.050	.076	.101	.126	.151	.177	.202	.227	.252	.303	20
25	.031	.063	.095	.126	.158	.189	.221	.252	.284	.316	.379	25
30	.038	.076	.114	.151	.189	.227	.265	.303	.341	.379	.454	30
35	.044	.088	.133	.177	.221	.265	.309	.353	.398	.442	.530	35
40	.050	.101	.151	.202	.252	.303	.353	.404	.454	.505	.606	40
45	.057	.114	.170	.227	.284	.341	.398	.454	.511	.568	.682	45
50	.063	.126	.189	.252	.316	.379	.442	.505	.568	.631	.757	50
60	.076	.151	.227	.303	.379	.454	.530	.606	.681	.757	.909	60
75	.095	.189	.284	.379	.454	.568	.663	.757	.858	.947	1.136	75
90	.114	.227	.341	.454	.568	.681	.795	.909	1.022	1.136	1.363	90
100	.126	.252	.379	.505	.631	.757	.883	1.010	1.136	1.262	1.514	100
125	.158	.316	.473	.631	.789	.947	1.104	1.262	1.420	1.578	1.880	125
150	.189	.379	.568	.757	.947	1.136	1.325	1.514	1.704	1.893	2.272	150
175	.221	.442	.663	.883	1.104	1.343	1.546	1.767	1.988	2.209	2.686	175
200	.252	.505	.757	1.010	1.262	1.514	1.767	2.019	2.272	2.524	3.029	200
250	.316	.631	.947	1.262	1.578	1.893	2.209	2.524	2.840	3.155	3.786	250
300	.379	.757	1.136	1.514	1.893	2.272	2.650	3.029	3.407	3.786	4.543	300
350	.442	.883	1.343	1.767	2.209	2.686	3.092	3.534	4.029	4.417	5.372	350
400	.505	1.010	1.514	2.019	2.524	3.029	3.534	4.038	4.543	5.048	6.058	400
500	.631	1.262	1.893	2.524	3.155	3.786	4.417	5.048	5.679	6.310	7.572	500

Gallons per Minute	75 Feet	90 Feet	100 Feet	125 Feet	150 Feet	175 Feet	200 Feet	250 Feet	300 Feet	350 Feet	400 Feet	Gallons per Minute
5	.094	.114	.126	.158	.189	.221	.252	.316	.379	.442	.505	5
10	.189	.228	.252	.316	.379	.442	.505	.631	.757	.883	1.010	10
15	.284	.341	.379	.470	.568	.663	.757	.947	1.136	1.343	1.514	15
20	.379	.454	.505	.631	.757	.883	1.010	1.262	1.514	1.767	2.019	20
25	.473	.568	.631	.783	.947	1.104	1.262	1.578	1.893	2.209	2.524	25
30	.568	.682	.757	.947	1.136	1.343	1.514	1.893	2.272	2.686	3.029	30
35	.663	.795	.883	1.104	1.325	1.546	1.767	2.209	2.650	3.092	3.534	35
40	.757	.909	1.010	1.262	1.514	1.767	2.019	2.524	3.029	3.534	4.038	40
45	.858	1.022	1.136	1.420	1.704	1.989	2.272	2.840	3.407	4.029	4.543	45
50	.947	1.136	1.262	1.578	1.893	2.209	2.524	3.155	3.786	4.417	5.048	50
60	1.136	1.363	1.514	1.880	2.272	2.686	3.029	3.786	4.543	5.372	6.058	60
75	1.420	1.704	1.893	2.366	2.840	3.313	3.786	4.733	5.679	6.626	7.572	75
90	1.704	2.044	2.272	2.820	3.407	3.975	4.543	5.679	6.815	7.951	9.086	90
100	1.893	2.272	2.524	3.155	3.786	4.417	5.048	6.310	7.572	8.834	10.096	100
125	2.366	2.820	3.155	3.916	4.699	5.483	6.310	7.887	9.399	10.965	12.620	125
150	2.840	3.407	3.786	4.699	5.679	6.625	7.572	9.465	11.358	13.251	15.144	150
175	3.313	3.975	4.417	5.483	6.625	7.729	8.834	11.042	13.431	15.459	17.668	175
200	3.786	4.543	5.048	6.310	7.572	8.834	10.096	12.620	15.144	17.668	20.192	200
250	4.733	5.679	6.310	7.887	9.465	11.042	12.620	15.775	18.930	22.085	25.240	250
300	5.679	6.815	7.572	9.399	11.358	13.431	15.144	18.930	22.716	26.502	30.288	300
350	6.626	7.951	8.834	10.965	13.251	15.459	17.668	22.085	26.502	30.919	35.336	350
400	7.572	9.086	10.096	12.620	15.144	17.668	20.192	25.240	30.288	35.336	40.384	400
500	9.465	11.358	12.620	15.665	18.930	22.085	25.240	31.550	37.860	44.170	50.480	500

In figuring the actual horse-power required to operate a pump, to deliver a given quantity of water, the "friction head" should be added to the "actual head" or elevation, and it is also necessary to take account of the efficiency of the pump.

To illustrate:

If the efficiency of a small pump is 33⅓%, the actual horse-power required is three times the theoretical.

If the efficiency is 50%, the actual horse-power is double the theoretical.

If the efficiency is 66⅔%, the actual horse-power is 1½ times the theoretical, etc.

Friction of Water in Pipes

Loss of Head in Feet Due to Friction per 100 Feet of NEW ORDINARY CAST IRON PIPE

Gal's per Min.	4 Inch Pipe		5 Inch Pipe		6 Inch Pipe		8 Inch Pipe		10 Inch Pipe		12 Inch Pipe		14 Inch Pipe		15 Inch Pipe		16 Inch Pipe		20 Inch Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
40	1.02	0.22																		
45	1.17	0.28																		
50	1.28	0.34																		
70	1.79	0.63	1.14	0.21																
75	1.92	0.73	1.22	0.24																
100	2.55	1.23	1.63	0.39	1.14	0.14														
120	3.06	1.71	1.96	0.57	1.42	0.25														
125	3.19	1.86	2.04	0.64	1.48	0.28														
150	3.84	2.55	2.45	0.88	1.71	0.32														
175	4.45	3.36	2.86	1.18	2.00	0.48														
200	5.11	4.37	3.27	1.48	2.28	0.62														
225	6.32	6.61	3.67	1.86	2.57	0.74														
250	6.40	6.72	4.08	2.24	2.80	0.92	1.60	0.22												
270	6.90	7.70	4.42	2.60	3.03	1.13	1.70	0.25												
275	7.03	7.99	4.50	2.72	3.06	1.15	1.73	0.27												
300	7.66	9.38	4.90	3.15	3.40	1.29	1.90	0.36												
350	8.90	12.32	5.72	4.19	3.98	1.69	2.20	0.41												
400	10.20	15.82	6.54	5.33	4.54	2.21	2.60	0.56												
450	11.50	19.74	7.35	6.65	5.12	2.74	2.92	0.64	1.80	0.21										
470	12.16	22.40	7.78	7.22	5.49	3.12	3.07	0.77	1.92	0.24										
475	12.30	22.96	7.88	7.42	5.55	3.21	3.10	0.79	1.94	0.25										
500	12.77	24.08	8.17	8.12	5.60	3.26	3.20	0.81	2.04	0.28	1.42	0.11								
550	......	......	8.99	9.66	6.16	3.93	3.52	0.98	2.25	0.33	1.57	0.14								
600	......	......	9.80	11.34	6.72	4.70	3.84	1.16	2.46	0.39	1.71	0.15								
650	......	......	10.62	13.16	7.28	5.50	4.16	1.34	2.66	0.46	1.85	0.19	1.37	.09						
700	......	......	11.44	15.12	7.84	6.38	4.46	1.54	2.86	0.52	2.00	0.22	1.47	.10						
750	......	......	12.26	17.22	8.50	7.00	4.80	1.74	3.06	0.59	2.13	0.24	1.58	.11						
800	......	......	......	......	9.08	7.90	5.12	1.97	3.28	0.67	2.27	0.27	1.68	.13						
850	......	......	......	......	9.58	8.75	5.48	2.28	3.48	0.75	2.41	0.31	1.79	.14						
900	......	......	......	......	10.30	10.11	5.75	2.46	3.68	0.83	2.56	0.34	1.89	.16						
950	......	......	......	......	10.72	10.71	6.06	2.87	3.88	0.91	2.70	0.35	2.00	.16	1.73	.12				
1000	......	......	......	......	11.32	12.04	6.40	3.02	4.08	1.01	2.84	0.41	2.10	.19	1.82	.14				
1050	......	......	......	......	11.90	13.30	6.70	3.21	4.29	1.09	2.98	0.48	2.20	.22	1.91	.16				
1100	......	......	......	......	12.50	14.31	7.03	3.51	4.50	1.20	3.13	0.49	2.31	.23	2.00	.16				
1150	......	......	......	......	12.95	15.34	7.35	3.84	4.71	1.34	3.27	0.53	2.42	.25	2.09	.17				
1200	......	......	......	......	13.52	16.69	7.67	4.26	4.91	1.46	3.41	0.57	2.52	.26	2.18	.19				
1250	......	......	......	......	14.10	18.20	8.00	4.45	5.11	1.51	3.55	0.62	2.63	.29	2.28	.20	1.99	0.15		
1500	......	......	......	......	......	......	9.60	6.27	6.10	2.09	4.20	0.85	3.15	.39	2.73	.28	2.39	0.24		
2000	......	......	......	......	......	......	12.70	10.71	8.10	3.50	5.60	1.43	4.20	.66	3.64	.47	3.19	0.39		
2500	......	......	......	......	......	......	......	......	10.10	5.33	7.00	2.18	5.25	1.01	4.55	.72	3.99	0.56		
3000	......	......	......	......	......	......	......	......	12.10	7.42	8.40	3.39	6.30	1.57	5.46	1.12	4.79	0.80	3.08	0.27
3500	......	......	......	......	......	......	......	......	14.10	10.08	9.80	3.92	7.35	1.82	6.37	1.29	5.59	1.04	3.59	0.35
4000	......	......	......	......	......	......	......	......	......	......	11.35	5.32	8.40	2.47	7.28	1.76	6.38	1.34	4.10	0.45
4200	......	......	......	......	......	......	......	......	......	......	11.93	6.30	8.82	2.92	7.64	2.08	6.72	1.45	4.32	0.50
4500	......	......	......	......	......	......	......	......	......	......	12.78	6.75	9.45	3.13	8.19	2.23	7.20	1.65	4.62	0.56
5000	......	......	......	......	......	......	......	......	......	......	14.20	8.15	10.50	3.78	9.10	2.69	7.96	2.02	5.13	0.68
5500	......	......	......	......	......	......	......	......	......	......	......	......	11.55	4.50	10.01	3.16	8.78	2.39	5.64	0.82
6000	......	......	......	......	......	......	......	......	......	......	......	......	12.60	5.40	10.92	3.79	9.56	2.84	6.15	0.96
6500	......	......	......	......	......	......	......	......	......	......	......	......	13.65	6.14	11.83	4.30	10.36	3.32	6.66	1.01
7000	......	......	......	......	......	......	......	......	......	......	......	......	14.70	6.65	12.74	4.66	11.12	3.68	7.18	1.28
7200	......	......	......	......	......	......	......	......	......	......	......	......	......	......	13.10	4.95	11.50	3.96	7.38	1.35
7500	......	......	......	......	......	......	......	......	......	......	......	......	......	......	13.65	5.60	11.95	4.28	7.66	1.45
8000	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	8.17	1.63
8500	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	8.68	1.83
9000	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	9.20	2.04
9500	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	9.70	2.23
10000	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	10.40	2.53

Vel.—Velocity ft. per second. Fric.—Friction head in feet.

Friction of Water in Pipes

Loss of head in feet due to friction, per 100 feet of NEW, SMOOTH, WROUGHT IRON PIPE

Gal's per Min.	½ inch Pipe		¾ Inch Pipe		1 Inch Pipe		1¼ Inch Pipe		1½ Inch Pipe		2 Inch Pipe		2½ Inch Pipe		3 Inch Pipe		4 Inch Pipe		5 Inch Pipe		6 Inch Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
1	1.05	1.50																				
2	2.10	5.30	1.20	1.40																		
3	3.16	11.30	1.80	2.90	1.12	0.90																
4	4.21	19.20	2.41	5.00	1.40	1.52	0.86	0.40	0.63	0.19												
5	5.26	29.00	3.01	7.50	1.86	2.32	1.07	0.60	0.79	0.28	0.51	0.09	0.33	0.05								
10	10.52	105.00	6.02	27.10	3.72	8.40	2.14	2.18	1.57	1.02	1.02	0.36	0.65	0.12	0.45	0.05						
15			9.02	57.00	6.13	18.90	3.92	4.65	2.72	2.25	1.53	0.81	0.98	0.25	0.68	0.11						
20			12.03	97.00	7.44	30.10	4.29	7.90	3.15	3.70	2.04	1.29	1.31	0.43	0.91	0.18						
25					9.30	45.50	5.36	11.90	4.56	5.60	2.55	1.96	1.63	0.66	1.13	0.27						
30					11.15	64.00	6.43	16.90	4.72	7.80	3.06	2.73	1.96	0.92	1.36	0.38						
35					13.02	85.00	7.51	22.30	5.51	10.30	3.57	3.66	2.29	1.23	1.59	0.51						
40					14.88	109.00	8.58	28.50	6.30	13.30	4.08	4.68	2.62	1.57	1.82	0.65	1.02	0.16				
45							9.68	35.20	7.08	16.60	4.60	5.80	2.95	1.97	2.02	0.80	1.17	0.20				
50							10.72	43.20	7.87	20.20	5.11	7.10	3.30	2.38	2.27	0.98	1.28	0.24				
70							15.01	81.00	11.02	37.60	7.15	13.20	4.60	4.42	3.18	1.83	1.79	0.45	1.14	0.15		
75									11.80	42.70	7.66	14.90	4.93	5.07	3.41	2.11	1.92	0.52	1.22	0.17		
100									15.74	73.00	10.21	25.60	6.54	8.60	4.54	3.52	2.55	0.88	1.63	0.29	1.14	0.10
120											12.25	36.00	7.84	12.00	5.45	4.97	3.06	1.22	1.96	0.41	1.42	0.18
125											12.75	38.90	8.16	13.01	5.68	5.40	3.19	1.33	2.04	0.46	1.48	0.20
150											15.30	54.00	9.80	18.72	6.80	7.72	3.84	1.82	2.45	0.63	1.71	0.23
175													11.43	23.70	7.92	9.75	4.45	2.40	2.86	0.84	2.00	0.34
200													13.07	30.90	9.08	12.80	5.11	3.12	3.27	1.06	2.28	0.44
225															10.42	16.00	6.32	4.72	3.67	1.33	2.57	0.53
250															11.28	19.70	6.40	4.80	4.08	1.60	2.80	0.66
270															12.45	22.70	6.90	5.50	4.42	1.86	3.03	0.81
275															12.70	23.60	7.03	5.71	4.50	1.94	3.06	0.82
300															13.62	27.10	7.66	6.70	4.90	2.25	3.40	0.92
350																	8.90	8.80	5.72	2.99	3.98	1.21
400																	10.20	11.30	6.54	3.81	4.54	1.58
450																	11.50	14.10	7.35	4.75	5.12	1.96
470																	12.16	16.00	7.78	5.30	5.49	2.23
475																	12.30	16.40	7.88	5.41	5.55	2.30
500																	12.77	17.20	8.17	5.80	5.60	2.33
550																			8.99	6.90	6.16	2.81
600																			9.80	8.10	6.72	3.36
650																			10.62	9.40	7.28	3.93
700																			11.44	10.80	7.84	4.56
750																			12.26	12.30	8.50	5.00
800																					9.08	5.64
850																					9.58	6.25
900																					10.30	7.22
950																					10.72	7.65
1000																					11.32	8.60
1050																					11.90	9.50
1100																					12.50	10.22
1150																					12.95	10.96
1200																					13.52	11.92
1250																					14.10	13.00